

### **REMARKS**

Applicant thanks the Examiner for the careful review of this application. Claims 1-14 were previously pending in this application. Claims 4-7 and 9 have been withdrawn from consideration. Accordingly, Claims 1-3, 8 and 10-14 are pending in this application.

### **OBJECTIONS TO SPECIFICATION**

The specification was objected to because of various informalities. The specification has been amended to clarify aspects of the invention.

Withdrawal of the objections is respectfully requested.

### **REJECTIONS UNDER 35 U.S.C. § 103(a)**

Claims 1-3 and 10-13 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,184,233 to Lim et al. (hereinafter "Lim") in view of Appl. Phys. Lett. 62 (10), by K.C. Lim et al. published on March 8, 1993 (hereinafter "K.C.")

Claims 1-3, 8 and 10-14 were rejected under 35 U.S.C. 103(a) as being unpatentable over Lim in view of Japanese Journal of Applied Physics, Part 1, Vol. 39, Number 11, pgs. 6393, by Masaki Tanaka et al. (hereinafter "Masaki").

The applicant respectfully traverses for the following reasons.

### **PRIOR ART**

Lim apparently discloses a composite material that has electrically conducting, elongated particles dispersed in a liquid crystal. The index of refraction to microwaves is controllable by the application of a transverse electric field that aligns the liquid crystal material and the particles. [Lim, Abstract] The microwave phase modulating cell includes a microwave wave guide, a phase modulating medium disposed within the wave guide and a means for controllably

aligning the particles and the liquid crystal in a first direction in the phase modeling medium. [Lim, col. 2, lines 15-22] The liquid crystal has two alignment states, parallel and perpendicular. [Lim, col. 4, line 65 - col. 5, line 2]

K.C. apparently discloses the birefringence of two common nematic liquid crystals that were measured in the millimeter wave range. K.C. tests a liquid crystal millimeter wave electronic phase shifter using liquid crystal electro – and magneto optical effects. [K.C., pg. 1]

Masaki apparently discloses nematic liquid-crystal cells with a grating-patterned electrode structure that is used in the visible wavelength region. The liquid crystal cells are fabricated and investigated experimentally in the millimeter-wave region. The millimeter-wave transmission properties of the liquid crystal cells are measured at 50 GHz with respect to the applied voltage, molecular orientations and polarization directions of the wave. The transmittances of the liquid crystal cells for the polarization direction parallel and perpendicular to the grating vector are 70-80% and 7-8% respectively. [Masaki, pg. 1]

#### PRIOR ART DISTINGUISHED

As provided above, Lim discloses a microwave modulating cell while K.C. and Masaki disclose liquid crystal cells in the millimeter wave range. In marked contrast, the claimed embodiment is directed to a terahertz (THz) phase shifter. The phase shifter in the claimed embodiment operates in the THz or sub-millimeter wave range while Lim operates in the microwave range and K.C. and Masaki operate in the millimeter wave range. The applicant respectfully submits that operating the liquid crystal in the sub-millimeter range is patentably distinct from operating the liquid crystal in the microwave range or the millimeter wave range.

Moreover, Lim and K.C. teach a phase shifter that is controlled by a magnetic or electric side field to achieve two states of liquid crystal alignment. Lim and K.C. do not teach a completely pure phase shifter or retarder because the molecular direction of the liquid crystal is either parallel or perpendicular to the polarization of incident electric-magnetic waves. Further, Masaki teaches the molecular direction of the liquid crystal is mostly parallel to the grating vector.

In further contrast to Lim and K.C., the claimed embodiment provides a continuously, widely and purely adjustable THz band phase shifter by using a rotatable magnet and a liquid crystal cell. In contrast to Masaki, the molecular direction of liquid crystal in the claimed embodiment will be always perpendicular to the polarization of the incident electric-magnetic waves. Thus, the claimed embodiment discloses a magnetic or electric field that adjusts the molecular direction of liquid crystals resulting in tunable phase, purely adjustable THz band phase shifter. Therefore, the applicant respectfully submits that neither Lim, K.C. nor Masaki, alone or in combination, renders the claimed embodiment obvious.

In contrast to Lim, K.C. and Masaki, Claim 1 contains the language, "a terahertz phase shifter," "a liquid crystal cell through which the THz wave propagates" and "thus providing a continuously adjustable phase shift." As provided above, neither Lim, K.C. nor Masaki teach a phase shifter operating in the terahertz range. Further, neither Lim, K.C. nor Masaki teach a phase shifter with continuously adjustable phase shift. Therefore, Lim, K.C. and Masaki do not render Claim 1 unpatentable. For at least these reasons, the independent Claim 1 is allowable over the teachings of Lim, K.C. or Masaki.

Claims 2-3 and 8 are either directly or indirectly dependent on the independent Claim 1. As described above, the independent Claim 1 is allowable over the teachings of Lim, K.C. and Masaki. Accordingly, Claims 2-3 and 8 are also at least allowable as being dependent on an allowable claim.

In contrast to Lim, K.C. and Masaki, Claim 10 contains the language, "a terahertz phase shifter," "a liquid crystal cell having a reflective refraction index suitable for THz wave propagation" and "wherein said magnetic field with adjustable direction and magnitude changes said reflective refraction index of said liquid crystal cell and an equivalent optical path of said THz wave." As provided above, neither Lim, K.C. nor Masaki teach a phase shifter operating in the terahertz range. Further, neither Lim, K.C. nor Masaki teach a phase shifter with continuously adjustable phase shift. Therefore, Lim, K.C. and Masaki do not render Claim 10 unpatentable. For at least these reasons, the independent Claim 10 is allowable over the teachings of Lim, K.C. or Masaki.

Claims 11-14 are either directly or indirectly dependent on the independent Claim 10. As described above, the independent Claim 10 is allowable over the teachings of Lim, K.C. and Masaki. Accordingly, Claims 11-14 are also at least allowable as being dependent on an allowable claim.

**CONCLUSION**

Applicant believes that all pending claims are now allowable. The applicant respectfully requests that all objections and rejections be withdrawn and a Notice of Allowance be issued at the earliest possible date.

The amendment was made to expedite the prosecution of this application. Applicant respectfully traverses the rejections of the amended claims and reserves the right to re-introduce them and claims of an equivalent scope in a continuation application.

If the Examiner believes that a conference would be of value in expediting the prosecution of this application, he is cordially invited to telephone the undersigned counsel at the number set out below.

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Respectfully submitted,  
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